DOCUMENT RESUME

ED 427 710 IR 019 261

AUTHOR Kashihara, Akihiro; Satake, Yoshitomo; Toyoda, Junichi
TITLE A History Visualization for Learning-by-Exploration in Hypermedia on WWW.
PUB DATE 1998-11-00
NOTE 9p.; In: WebNet 98 World Conference of the WWW, Internet and Intranet Proceedings (3rd, Orlando, FL, November 7-12, 1998); see IR 019 231. Figures may not reproduce clearly.
PUB TYPE Reports - Descriptive (141) -- Speeches/Meeting Papers (150)
EDRS PRICE MF01/PC01 Plus Postage.
DESCRIPTORS Computer Interfaces; Discovery Processes; Foreign Countries; *Hypermedia; Information Systems; *Navigation (Information Systems); Online Searching; Search Strategies; User Needs (Information); *Visualization; *World Wide Web
IDENTIFIERS Browsing; Web Sites

ABSTRACT

In the context of exploring educational hypermedia on the World Wide Web, this paper presents a history visualization that helps learners reorganize explored contents to find what Web sites they should visit next. Learning-by-exploration is discussed as it relates to educational hypermedia, including the "Get Lost in Hyperspace" problem, learning support approaches, and current work on hypermedia exploration aids. A history visualization tool (HiVis) is presented. The HiVis user interface and three types of visualization that are not currently implemented in standard Web browsers are described: (1) time sequential representation with contextual information; (2) structural representation; and (3) superposition on an overview diagram. A preliminary evaluation of HiVis is summarized; results indicate that the history visualization is informative for learners. Figures present the HiVis interface, a time sequential representation, structural representation, and superposition representation. Contains 11 references. (Author/AEF)

****
* Reproductions supplied by EDRS are the best that can be made *
* from the original document. *
****

ED 427 710

A History Visualization for Learning-by-Exploration in Hypermedia on WWW

Akihiro Kashihara, Yoshitomo Satake, and Jun'ichi Toyoda
The Institute of Scientific and Industrial Research, Osaka University, JAPAN
E-mail: kasihara@ai.sanken.osaka-u.ac.jp

Abstract: Educational hypermedia provide learners with hyperspace where they can explore with a learning purpose in a self-directed and constructive way. As the exploration progresses, however, what and why they explored so far often become unclear. They cannot finally find what to explore next. In order to resolve this situation, it is necessary to reflect on to what extent they learned and what is insufficient for achieving a learning purpose. This also requires them to think back to their history and to reorganize the contents they explored. In the context of exploring educational hypermedia provided on WWW, this paper presents a history visualization which helps learners reorganize the explored contents to find what they should visit next. This paper also describes a history visualization tool called *HiVis*, and its preliminary evaluation. The results indicate that the history visualization is informative for learners.

1. Introduction

In the last few years, there have been increasingly provided various types of hypermedia on WWW, which are designed from an educational point of view, or which are worth learning. Learning with such educational hypermedia has become more and more important [Brusilovsky 1997].

Educational hypermedia generally provide hyperspace where learners can explore in a self-directed, self-regulated, and constructive way [Kashihara et al. 1997]. In exploring with a learning purpose, however, what and why the learners explored so far often become unclear as the exploration progresses. They can not finally find what to explore next for achieving the learning purpose. This is a well-known problem in hypermedia called "*get lost in hyperspace*" problem [Nielsen 1990; Conklin 1988].

Current work on hypermedia systems provides several navigational aids [Brusilovsky 1996], which present users with the candidates they should explore next. These aids can help learners who know what to explore next, and who do not know where it is. However, the navigational aids are not so fruitful for learners who do not know what to explore next since they cannot understand why they should follow one of the candidates. In order to resolve the "*get lost in hyperspace*" situation, it is indispensable to reflect on to what extent the learners learned and what is insufficient for achieving a learning purpose. This also needs to think back to their history in the hyperspace to reorganize the contents they explored.

In current hypermedia systems, an exploration history is often visualized so that learners can pay attention to it. However, it is done in a straightforward way. More informative visualization requires greater consideration of what to and how to visualize in regard to learners' history, which is the main issue addressed in this paper.

In the context of exploring hypermedia on WWW with one learning purpose, this paper proposes a history visualization, and presents a history visualization tool called *HiVis* (History Visualization). *HiVis* monitors the learners' exploration activities to make history, which includes the hypermedia nodes (WWW documents) and links they visited. The history is visualized on their demand so that the learners' exploration cannot be restricted as much as possible. *HiVis* provides three types of visualization which are not currently implemented in standard WWW browsers such as Netscape Navigator or Microsoft Internet Explorer. This paper also describes a

BEST COPY AVAILABLE

IR019261

U.S. DEPARTMENT OF EDUCATION
Office of Educational Research and Improvement
EDUCATIONAL RESOURCES INFORMATION CENTER (ERIC)
☐ This document has been reproduced as received from the person or organization originating it.
☐ Minor changes have been made to improve reproduction quality.
• Points of view or opinions stated in this document do not necessarily represent official OERI position or policy.

BEST COPY AVAILABLE

"PERMISSION TO REPRODUCE THIS MATERIAL HAS BEEN GRANTED BY
G.H. Marks
TO THE EDUCATIONAL RESOURCES INFORMATION CENTER (ERIC)."

preliminary evaluation of *HiVis* with four subjects. The results indicate that the history visualization is informative for learners.

2. Learning-by-Exploration

2.1 "*Get Lost in Hyperspace*" Problem

Educational hypermedia provide learners with a hyperspace where they can explore in a self-directed and self-regulated way. In the hyperspace, learners can learn the hypermedia material with a learning purpose in a constructive way. As the work on cognitive science pointed out, the mental efforts involved in the exploration contributes to enhancing learning [Carroll et al. 1985]. However, the constructive learning by exploration is not so easy [Kashihara et al. 1997]. As the exploration progresses, what and why learners explored so far often become unclear. At last, the learners cannot find what to explore next for achieving the learning purpose. This is called a "*get lost in hyperspace*" problem.

2.2 Learning Support

Resolving the "*get lost in hyperspace*" problem requires learners to reflect on to what extent they learned so far. This also requires them to reorganize the contents they explored. One approach to this problem is to present the learners with the candidates to be explored next [Brusilovsky 1996]. This allows them to focus on reorganizing the explored contents. However, such a navigational aid would not work effectively unless the learners have their consciousness of reorganizing what they explored. In addition, it reduces the opportunities for them to explore other places in the hyperspace, reducing mental efforts to be involved in the exploration and the intrinsic effectiveness of learning-by-exploration [Zeiliger et al. 1997; Kashihara et al. 1997].

The other approach is to give learners some support on their demand so that exploration activities cannot be restricted as much as possible [Zeiliger et al. 1997]. This means to encourage the learners to make suitable mental efforts in exploring [Carroll et al. 1985; Kashihara, Hirashima, and Toyoda 1995]. Following this approach, we propose a history visualization which helps learners reorganize their exploration history, and find what to explore next in hyperspace. The history visualization should fulfill the following requirements.

Reorganizing history first requires learners to reproduce the thought processes during their exploration in hyperspace. It also requires them to rethink the history from several viewpoints. Second, finding what to explore next requires learners to recognize to what extent they accomplished a learning purpose. The history should be accordingly visualized so that such reproduction, rethinking, and recognition can be facilitated.

2.3 Related Work

Current work on hypermedia systems has provided a number of exploration aids. The representative aid related to history visualization is graphical overview diagrams. Graphical overview diagrams display hypermedia nodes and links [Domel 1994; Mukherjea and Foley 1995]. They can be also views of already visited subspace. They are generally generated and displayed before learners start exploring. The diagrams allow learners to directly access the hypermedia nodes by clicking on the corresponding nodes in the diagrams. These diagrams can inform the learners where they are, where they have already visited, and where they have not visited. However, there are some problems as follows.

The original network structures that hypermedia have are usually very complicated. They are accordingly filtered so that they can be understandable for learners. The filtered network structures result in overview diagrams [Mukherjea, Foley, and Hudson 1995]. Exploring with such diagrams is more restricted compared to exploring the

original hypermedia. In addition, overview diagram generators on WWW usually attach URLs of WWW documents or title tags in the HTML files to nodes in overview diagrams [Mukherjea and Foley 1995; Domel 1994]. Learners may consequently have difficulty in recalling the contents of the visited nodes.

3. *HiVis*

In this section, we discuss what kinds of history visualization are necessary, and demonstrate *HiVis*.

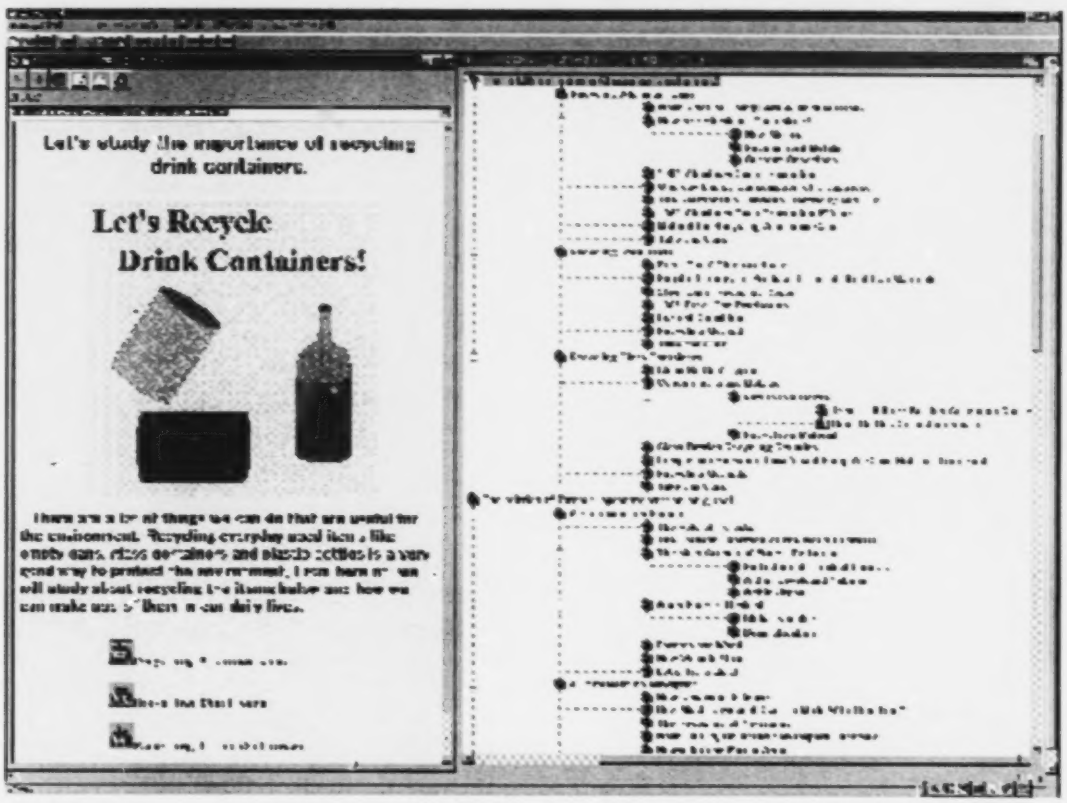

Figure 1: Interface of *HiVis*

3.1 Interface

Before discussing the history visualization, let us present the user interface of *HiVis* in Figure 1. In Figure 1, a learner visits the homepage of hypermedia material "Recycling of drink containers." Exploring WWW documents with one learning purpose in the left window, the learner can look at his/her history in the right window when necessary. The interface monitors the nodes (WWW documents) and links he/she explored to make a history including the contextual information.

BEST COPY AVAILABLE

3.2 History Visualization

3.2.1 Time Sequential representation

In order to encourage learners to reproduce the thought processes during their exploration, *HiVis* visualizes the contextual information of what, how long, and why they visited so far.

As shown in Figure 2, *HiVis* sequences the nodes in order of time a learner visited. Each node is labeled the descriptor of the anchor he/she selected for exploring it in the previous nodes. During exploring the hypermedia, the learner is requested to describe the reason why he/she visits the next node whenever he/she pushes the anchor. Some examples of the reasons are (1) to go back to the previous node, (2) to look at the detailed explanation, (3) to receive an answer to question, (4) to look into related items, etc. *HiVis* tags the reasons between nodes in the time sequential representation as shown in Figure 2. *HiVis* also displays how long the learner visited each node. This may allow him/her to confirm which node is more important according to the length of time they visited.

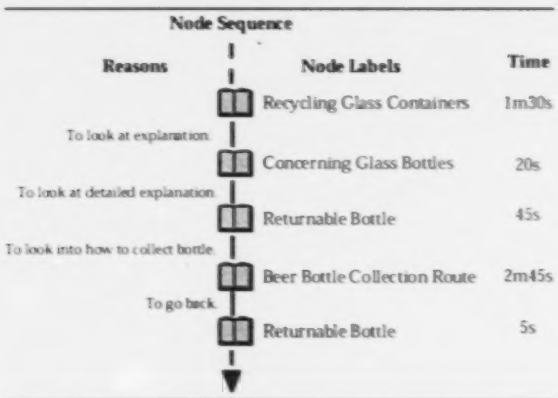

Figure 2: A Time Sequential Representation

Figure 3: A Structural Representation

Clicking on one node in the time sequential representation, he/she can review the corresponding hypermedia node in case he/she cannot recall the contents of the node.

3.2.2 Structural representation

In order to give learners another viewpoint of thinking back to their history, *HiVis* superposes the history on an overview tree diagram described in 3.2.3 to display the sub-tree which comprises all visited nodes. This sub-tree allows the learners to find the structural relationships between any visited nodes, which they tend to overlook during exploring. The sub-tree may also stimulate them to group some visited nodes and their contents according to the structural relationships.

Figure 3 shows a sub-tree representation of history in which a learner explored "Recycling of drink containers." He/she can focus on reorganizing the visited contents from a structural point of view.

BEST COPY AVAILABLE

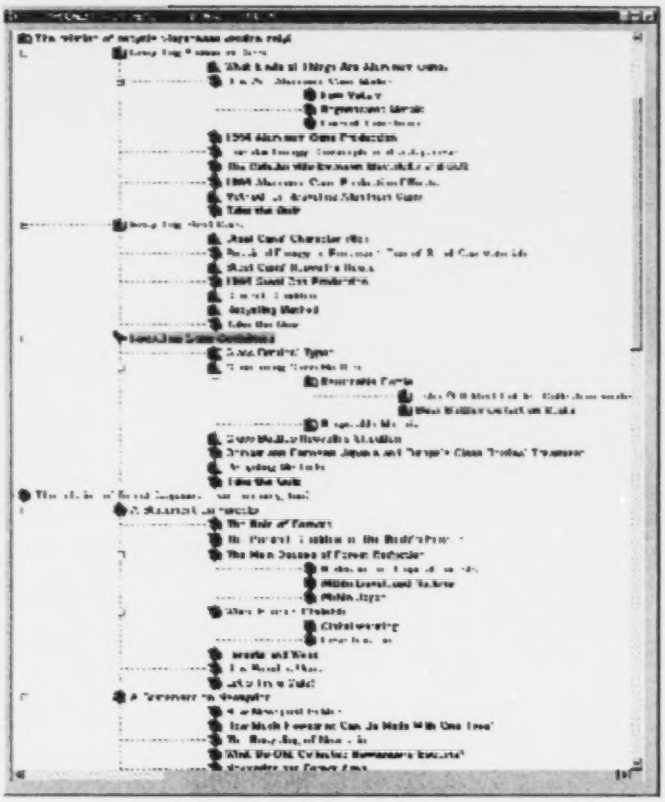

Figure 4: A Superposition Representation

3.2.3 Superposition on Overview Diagram

It is not so easy for learners to know to what extent they learned so far for achieving a learning purpose. Assuming that hypermedia material includes information necessary for the purpose achievement, *HiVis* accordingly superposes their history on an overview diagram, and visualizes the subspace they have visited and the subspace they have not visited.

The overview diagram is represented as tree. Although the root is usually the homepage of hypermedia material, learners can choose any WWW document as the root. The tree is generated from the root. *HiVis* regards nodes to which the anchors included in the root point as the child nodes. The descriptors of the anchors are attached on the child nodes. However, the anchors linking to the different servers or the ones going back to the parent nodes are omitted. *HiVis* continues finding child nodes until there are no anchors in the parent nodes.

Figure 4 shows a superposition representation with the history represented in Figure 3. The nodes learners have not visited are represented with a book icon which is closed; the nodes they visited, a book icon which is open. If an overview tree diagram is too large, *HiVis* visualizes only the neighborhood of visited nodes.

3.3 Preliminary Evaluation

BEST COPY AVAILABLE

We had a preliminary evaluation of *HiVis* with four subjects who were graduate students. The subjects were asked to explore "Recycling of drink containers" with a learning purpose that is to find the differences in recycling each drink container. After exploring for a while, they were then asked to use the history visualization facility. After that, they were asked whether the history visualization is informative, and what information they got from it. The results were as follows.

Each visualization was informative as expected for all subjects. It also gave them the expected information. In addition, we got an opinion that one subject could understand why he/she did not explore nodes from the superposition representation. This means the visual representation provides the information necessary for selecting what to explore next. Some subjects also had opinions that they could not find the order of nodes they explored in the structural representation and in the superposition representation. However, these are not negative for the history visualization since the subjects should look at the time sequential representation of the history. In this case, it seems they did not well know how to properly use three types of the history visualization.

4. Conclusions

In this paper, we have presented a history visualization for learners to resolve "*get lost in hyperspace*" situation in which they do not know what to explore next. This paper has also demonstrated *HiVis* which provides learners with three types of history visualization: time sequential representation with contextual information, structural representation, and superposition representation. The time sequential and structural representations stimulate learners to reorganize the contents they visited so far; the superposition representation, to choose what to explore next. The learners are expected to use these visual representations properly.

We also had a preliminary evaluation of *HiVis*. As a result, the history visualization was informative. In the future, we should have more detailed evaluation to make problems clearer, refining the history visualization provided by *HiVis*.

References

[Brusilovsky 1996] Brusilovsky, P. (1996). Methods and Techniques of Adaptive Hypermedia, *Journal of User Modeling and User-Adapted Interaction*, 6, 87-129.

[Brusilovsky 1997] Brusilovsky, P. (1997). Distributed Intelligent Tutoring on the Web, *8th World Conference on Artificial Intelligence in Education*, 482-489.

[Carroll et at. 1985] Carroll, J., Mack, R., Lewis, C., Grischkowsky N., & Robertson S., (1985). Exploring exploring a word processor, *Journal of Human-Computer Interaction*, 1, 283-307.

[Conklin 1988] Conklin, J. (1988). Hypertext: An Introduction and Survey, *Computer* 20 (9), 17-41.

[Domel 1994] Domel, P. (1994). WebMap -A Graphical Hypertext Navigation Tool, *Second International WWW Conference*.

[Kashihara, Hirashima, and Toyoda 1995] Kashihara, A., Hirashima, T., & Toyoda, J. (1995). A Cognitive Load Application in Tutoring, *Journal of User Modeling and User-Adapted Interaction* , 4(4), 279-303.

[Kashihara et al. 1997] Kashihara, A., Kinshuk, Oppermann, R., Rashev, R., & Simm, H. An Exploration Space Control as Intelligent Assistance in Enabling Systems, *International Conference on Computers in Education '97* , Association for the Advancement of Computing in Education, Charlottesville, VA., 114-121.

[Mukherjea and Foley 1995] Mukherjea, S., & Foley, J. (1995). Visualizing the WWW with the Navigational View Builder, *Third International WWW Conference*.

[Mukherjea, Foley, and Hudson 1995] Mukherjea, S., Foley, J., & Hudson, S. (1995). Visualizing Complex Hypermedia Networks through Multiple Hierarchical Views, *ACM SIGCHI '95*.

[Nielsen 1990] Nielsen, J. (1990). The Art of Navigating Hypertext, *Communication of the ACM*, 33(3), 297-310.

[Zeiliger et al. 1997] Zeiliger, R., Reggers, T., Baldewyns, L., & Jans, V. (1997). Facilitating Web Navigation: Integrated Tools for Active and Cooperative Learners, *International Conference on Computers in Education '97* , Association for the Advancement of Computing in Education, Charlottesville, VA., 529-537.

Acknowledgments

This research is supported in part by CASIO SCIENCE PROMOTION FOUNDATION and in part by Grant-in-Aid for Scientific Research from the Ministry of Education, Science and Culture of Japan.